# Colorado River
# Salinity Control Program
# Uintah Basin Unit
## 2003 Annual Report

U.S. Department of Agriculture
Natural Resources Conservation Service
March 22, 2003

## Table of Contents

**Table of Contents** ..... **2**

**Executive Summary** ..... **3**

Table 1 – Program Summary ..... 4

For further information, please contact: ..... 4

**Hydro-salinity** ..... **5**

Figure 1. Average Mountain Precipitation. ..... 6

Figure 2. Total Salt Load, Duchesne River near Randlett ..... 7

**Wildlife Habitat and Wetlands** ..... **7**

**Economics** ..... **9**

Appendix 1, 2003 Cooperator's Survey Summary. ..... 10

Appendix 2 – Examples of Wildlife Habitat Replacement Practices. ..... 11

Appendix 3. Case Study ..... 12

Farm Description ..... 12

**References** ..... **13**

# Executive Summary

## Overview

In 2003, an additional 26 cooperators returned survey questionnaires concerning program participation. To date, 452 surveys have been completed, reflecting a generally positive public attitude toward salinity control programs.

## Hydro-Salinity

The effectiveness of properly installed and operated sprinkler systems in reducing deep percolation and salt loading is well established by countless on-farm evaluations in the past (Draper et al.). Cooperator surveys continue to verify that the vast majority of participants are anxious to operate their equipment properly and efficiently, achieving projected salt load reductions.

One irrigation seminar was presented in the Uintah Basin last year. Irrigation Water Management Contracts receive great emphasis, with the goal of teaching and demonstrating valid IWM techniques that will enhance production while achieving salt load reduction goals.

Random system efficiency spot checks are being used to assure that projected salt load reductions are being realized.

Through the end of 2003, calculated annual salt loading has been reduced by 123,531 tons/year, with an estimated $77.8 million[1] invested.

## Wildlife Habitat

No area-wide wildlife habitat or wetland monitoring was done in 2003 due to late budget appropriation.

On farm wildlife habitat creation/enhancement planned and funded in 2003 is 381 acres. On farm wildlife habitat creation/enhancement implemented in 2003 is 384 acres. The first 360 acres of WHIP program in the Uintah Basin were implemented in 2003.

Wildlife habitat replacement will continue to be encouraged and implemented on a voluntary basis.

## Economics

Economic benefits to cooperators are apparent. A large majority of survey respondents believe that their share of the cost has or will pay out due to improved operating efficiencies.

Nearly all respondents believe that salinity control programs have had a positive economic affect on the area and region.

## Conclusions

The original environmental evaluation estimated an ultimate salt load reduction of 111,210 tons/year. In 2002, the salt load reduction goal was increased to 140,500 tons/year, based on greater acceptance of sprinkler practices than originally anticipated. At the end of Fiscal 2003, cumulative salt load reduction was estimated to be 123,531 tons/year. Many economic opportunities remain for additional reductions.

Future M&E efforts will focus on additional cooperator surveys, remote sensing evaluations of wildlife habitat, and the gathering and analysis of area wide production/irrigation data. By so doing, the value and effectiveness of salinity control measures can be quantified with modest resources.

Table 1 summarizes project status.

[1] $55,596,190 (Financial Assistance) + 40% (Technical Assistance) = $74 million.

**Table 1 – Program Summary**

| Uintah Basin Summary, 2003 (from Mason Report, 2003) | | | |
|---|---|---|---|
| **Practices Applied** | **Unit(s)** | **2003 FY** | **Cumulative** |
| **1. Irrigation Systems** | | | |
| **A. Sprinkler** | Acres | 4,387 | 105,207 |
| **B. Improved Surface System** | Acres | 80 | 14,122 |
| **C. Drip Irrigation System** | Acres | 3 | 64 |
| **2. Irrigation Water Management** | Acres | 9,550 | 101,533 |
| **3. Wildlife Wetland Habitat Mgt** | Acres | 2 | 2,617 |
| **4. Wildlife Upland Habitat Mgt** | Acres | 22 | 14,850 |
| **5. Salt Load Reduction** | Tons/Year | 10,047 | 123,531 |
| **6. Deep Percolation Reduction (includes seepage) Note: deep percolation is not equal to return flow** | Acre FT/Year | 5,517 | 77,092 |
| **7. Total Contracts since inception of all five programs; CRSC, ACP, IEQIP, EQIP, BSPP** | Number | 2,427 | |
| | Dollars | 55,596,190 | |
| | Acres | 121,358 | |

| Salinity Control Programs | | | |
|---|---|---|---|
| **Program** | **Acronym** | **Start YR** | **End YR** |
| **Agricultural Conservation Program** | ACP | 1980 | 1987 |
| **Colorado River Salinity Control** | CRSC | 1987 | 1996 |
| **Interim Environmental Quality Incentive Program** | IEQIP | 1997 | 1997 |
| **Environmental Quality Incentive Program** | EQIP | 1997 | Present |
| **Basin States Parallel Program** | BSPP | 1998 | Present |

**For further information, please contact:**

Jim Spencer, Wildlife Biologist
USDA-NRCS
240 West Highway 40 (333-4)
Roosevelt, UT 84066
(435)722-4621 ext 128
jim.spencer@ut.usda.gov

Ed Whicker, Civil Engineer
USDA-NRCS
240 West Highway 40 (333-4)
Roosevelt, UT 84066
(435)722-4621 ext 124
ed.whicker@ut.usda.gov

## Hydro-salinity

Before implementation of salinity control measures, the Uintah Basin contributed an estimated 450,000 tons of salt per year into the Colorado River (Dept. of Interior, 2001).

Two basic assumptions guide the calculation of salt load reductions from irrigation activities:

1. The salinity concentration of subsurface return flow from irrigation is constant, regardless of the amount of canal seepage or on farm deep percolation. The supply of mineral salts in the soil is infinite and the salinity of the out flowing water is dependant only on the solubility of the salts in the soil. Therefore, salt loading is directly proportional to the volume of subsurface return flow. (Hedlund, 1992)
2. Water that percolates below the root zone of the crop and is not consumed by plants or evaporation will eventually find its way into the river system. Salt loading into the river is reduced by reducing deep percolation.

Deep percolation (and proportional salt load) reductions are achieved by reducing or eliminating canal/ditch seepage and by improving the efficiency of surface irrigation. It is estimated that upgrading an uncontrolled flood irrigation system to a well designed sprinkler system will reduce deep percolation (and salt load) by 80-90%.

NRCS salinity control programs focus on helping cooperators improve irrigation systems, better manage water use, and sharply reduce deep percolation/salt loading.

Federal agencies have been tasked to "*Provide continuing technical assistance for irrigation water management as well as monitoring and evaluation of changes in salt contributions to the Colorado River to determine program effectiveness"* (Dept. of Interior, 2001).

There is an ongoing program of monitoring and evaluating past installations, designed to determine the effectiveness of these programs.

In the past, detailed studies of installed irrigation systems determined that when operated as designed and approved, irrigation efficiencies were greatly enhanced and deep percolation sharply reduced (Draper et al., 2001).

Draper et al. (2001) cites an average cumulative irrigation efficiency of 84% for sprinklers and 66% for improved surface irrigation.

To evaluate continued conformance with approved design, systems are randomly evaluated on the basis of:

1. Cooperator questionnaires, interviews, and training sessions
2. Equipment spot checks and evaluations
3. Long term system evaluations
4. Case studies.

### Cooperator questionnaires, interviews, and training sessions

In 2002, 426 cooperators were surveyed do determine their perceptions and attitudes about salinity control practices installed on their property. In 2003, an additional 50 cooperators in Duchesne County were randomly selected and mailed surveys. To date, 26 questionnaires have been returned. These surveys generally indicate that the vast majority of cooperators are pleased with results and are generally satisfied with contracts they have entered into. Most respondents indicate that they continue to operate per the original design and are interested in continuing responsible water management practices.

Observations from this year's surveys include:

- 96% of installed systems are operating as designed or with operator installed improvements (99.5% last year).
- 96% of respondents believe their share of the cost has or will pay out due to improved operating efficiencies (89% last year).
- 100% of respondents believe that salinity control programs have had a positive economic affect on the area and region (95% last year).

- 62% of respondents measure their water (60% last year).
- 24% of respondents monitor soil water content, mostly by the "feel" method (51% last year).
- 54% of respondents have never attended a water management class, workshop, or demonstration, except for orientation received during design and construction phases of their project (24% last year).
- 15% of respondents employ or use a consultant or service that advises irrigation scheduling (1% last year).
- Two respondents complained of increasing maintenance costs due to aging of their equipment (17-20 years in service).

A summary of survey responses for 2003 is in appendix 1.

To educate cooperators and encourage conservative water management, Dinosaurland Resource Conservation and Development District continues to sponsor Water Management Seminars each year. In addition, each cooperator is given individual instruction and written procedures to help efficiently operate new irrigation equipment. NRCS personnel are available for additional explanation and education any time the cooperator requests.

## Equipment spot checks and evaluations

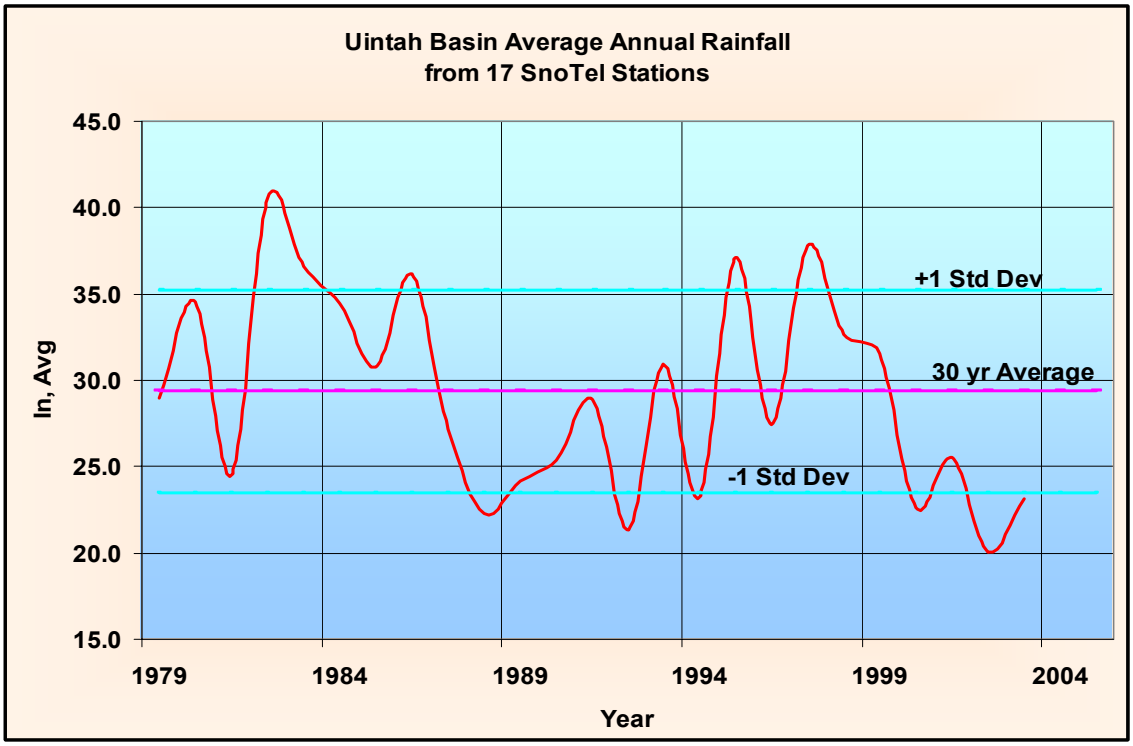
Due to budget delays, no catch can testing was done in the Uintah Basin in 2003. However, several systems were measured for total volume, using sonic velocity meters. All of the measured systems were performing within a reasonable tolerance of design flow. Sixteen year old brass nozzles on one farm were flowing within 8% of their designed volume.

## Long term system evaluations

Three systems have been monitored for several years, recording hourly flow and daily water management calculations based on local weather data and calculated consumptive use. All three systems indicated virtually no runoff and no deep percolation for the 2003 season.

Irrigation water was not plentiful in 2003, and water shortages tend to reduce deep percolation. Figure 1 is a graph of mountain precipitation for the Uintah Basin.

**Figure 1. Average Mountain Precipitation.**



## Case Study

In 2003, a case study was completed on a system of three wheel lines and a pivot, installed in 1987. While the wheel lines are showing some wear on the connection ends, water management calculations indicate that installed systems operate with no runoff or deep percolation. A brief report of the case study is included in appendix 4.

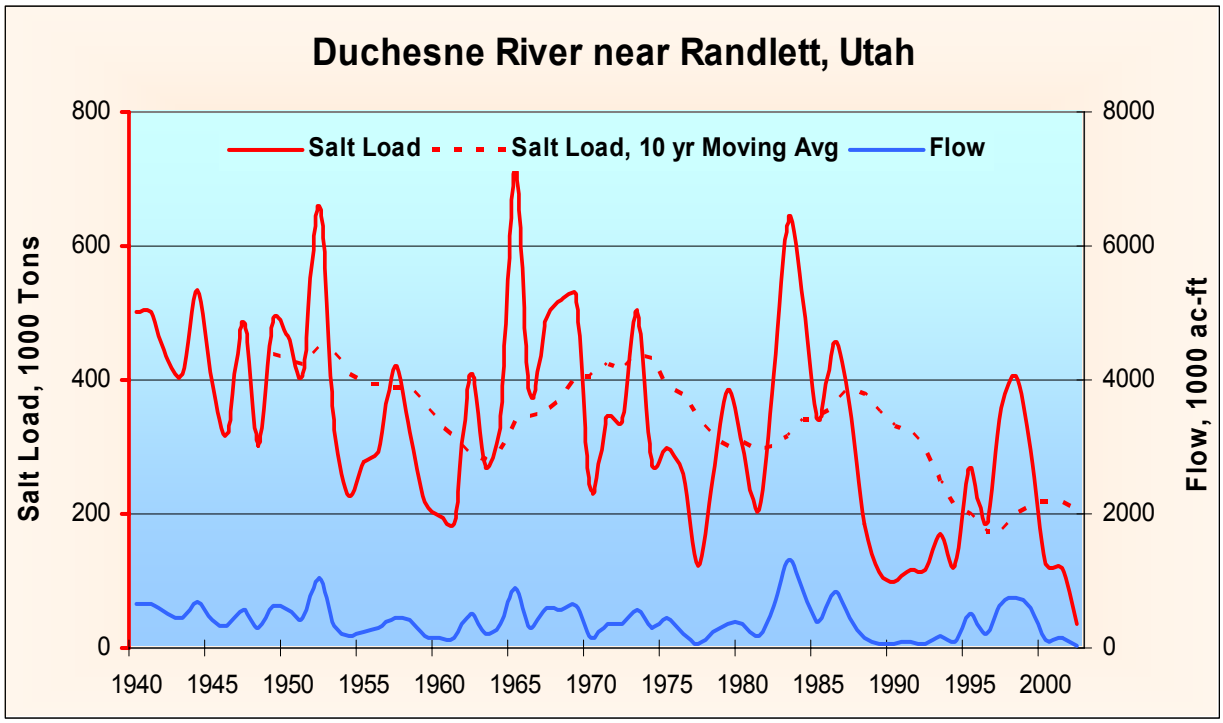
All indications are that the vast majority of systems in operation, are maintained and operated properly, and projected salt load reductions are being achieved. Cooperators are interested in managing their water responsibly and are generally open to instruction and training that will help them.

At this stage, returning to flood irrigation is impossible, as installed pipelines are not capable of delivering adequate volumes for flooding. Those few cooperators who have stopped using their systems are simply not irrigating and not contributing any salt. The permanence and longevity of continued responsible sprinkler irrigation seems assured.

## Salt Load from Irrigation

Federal agencies are also tasked to "*determine the salt load resulting from irrigation . . . practices"* (Dept. of Interior, 2001). The effectiveness of salt load reduction in the river system has been studied and assessed by the U.S. Geological Survey (USGS) and U.S Bureau of Reclamation (BOR). Their evaluations seem to indicate that salt loading in the river has been reduced significantly. Measured salt levels appear to be stable or down trending. Figure 2 is a graph of the calculated salt load in tons/year carried at the USGS gauging station on the Duchesne River, near Randlett (downstream of most Duchesne County irrigation).

**Figure 2. Total Salt Load, Duchesne River near Randlett**




## Wildlife Habitat and Wetlands

## Background

Wildlife habitat monitoring in the Uintah Basin was performed from 1984 to 1999 at 90 selected sites throughout the area. These 90 sites were monitored on a three-year rotation by visiting 30 sites each year. A monitoring team collected data on site for habitat quality to be evaluated, utilizing the Habitat Evaluation Procedures (HEP, 1980).

Along with the 90 HEP sites, 18 vegetative transects were monitored using species frequency sampling methods and a Daubenmire cover class frame. These transects are located on various parts of the landscape, and were also evaluated on a three year rotation period by visiting six transects per year. The

purpose of the information gathered from these transects was to provide insight on changes occurring in habitat composition and also changes in wetland plant communities.

Due to a decrease of funding, wildlife habitat monitoring efforts were reduced in 1997 and discontinued in 1999. Two new employees, a biologist and a civil engineer, were hired in September 2002 as the new Monitoring and Evaluation (M&E) team. This report reflects a state of transition of staff as well as methodology for the M&E effort.

It has been proposed to the Executive Committee for the Colorado River Basin Salinity Control Program in Utah, that new methods for Wildlife Habitat and Wetlands M&E be used beginning in 2003.

## On-Farm and Off-Site Wildlife Habitat Monitoring

The NRCS plan is to utilize Geospatial technology techniques to monitor wildlife habitat and wetland extent changes as the preferred methodology for M&E data gathering. In 2003:

- Satellite imagery was purchased for the Uintah Basin and the Price-San Rafael River Basins.
- Remote sensing image processing software and hardware was purchased to process the images.
- On the ground surveys were completed for use in ground truthing when the equipment is installed and functioning.
- Due to the delay in the FY 2003 budget, software and hardware were not purchased until late in the year, after the growing season. This delay prevented any data from being analyzed for the 2003 M&E report.

## On-Farm Habitat

There were no EQIP (Wildlife only) or Basin States Parallel Program (BSPP) (Wildlife only) projects planned or funded in FY 2003. Six Wildlife Habitat Incentive Program (WHIP) contracts were planned and funded in FY 2003 in the Uintah Basin for a total of 381 acres to be treated.

The total wildlife habitat created or enhanced in FY 2003, in the Uintah Basin, using EQIP, WHIP, and BSPP programs, was 384 acres. The majority of applied practices were WHIP (360 acres). Three hundred sixty WHIP acres implemented in 2003 represent the total amount of land treated under the WHIP program since its inception in 1997, in the Uintah Basin (see Table1 and Table 2 below). Some of the practices utilized in the implemented projects were Upland Wildlife Habitat Management (645), Wetland Wildlife Habitat Management (644), Ponds (378), Tree and Shrub Establishment (612), Fencing (382), Pipeline for Irrigation Water Conveyance (430DD). The implemented projects used irrigation water to maintain and enhance artificial wetlands for the primary benefit of wildlife.

**Table 1.**

Acres of Wildlife Habitat Creation or Enhancement planned and funded in the Uintah Basin by Program and County in 2003.

| | EQIP (Wildlife only) | WHIP | BSPP (Wildlife only) |
|---|---|---|---|
| Duchesne County | 0 | 245 | 0 |
| Uintah County | 0 | 136 | 0 |

**Table 2.**

Acres of Wildlife Habitat Creation or Enhancement Implemented in the Uintah Basin by Program and County in 2003.

| | EQIP (Wildlife only) | WHIP | BSPP (Wildlife only) |
|---|---|---|---|
| Duchesne County | 3 | 360 | 0 |
| Uintah County | 2 | 0 | 19 |

## Off-Farm Habitat

With hardware and software now installed and functioning, satellite imagery will be utilized in next years report to track changes in cover types, within and adjacent to project area agricultural lands, surrounding uplands, urbanization, and riparian and wetland areas downstream of project activities.

Some ground verification of cover types in the field was performed in 2003 to create an adequate level of confidence in the remotely sensed data. During field checks, special attention was given to features such as field borders, ditch bank habitats, wildlife travel corridors and riparian/wetland areas.

### Voluntary Habitat Replacement

The NRCS will continue to encourage replacement of wildlife habitat on a voluntary basis. Federal and State funding programs are in place to promote wildlife habitat replacement. Programs include the Environmental Quality Incentive Program (EQIP), Wildlife Habitat Incentive Program (WHIP), and Basin States Parallel Salinity/Wildlife Only funds (BSPP), Wetlands Reserve Program (WRP), Grassland Reserve Program (GRP), Conservation Reserve Program (CRP), and Continuous Sign-up Conservation Reserve Program CCRP). Field Offices have several wildlife habitat projects in various stages of planning.

Procedures for implementing wildlife habitat replacement are specified in the NRCS Field Office Technical Guide (FOTG), Section IV, and routinely used in contract development. See Appendix 3, for an example of the practices that may be reported for wildlife habitat replacement purposes.

## Economics

Past studies indicate that in virtually all cases, the proper installation of sprinklers and education of the farmer result in increased yield and reduced labor. As reported previously in this document, 96% of this year's survey respondents believe their share of the cost of salinity control projects has or will pay out due to increased yields and reduced labor costs.

A case study completed in 2003, cites a doubling of dairy and beef herds after installation of a center pivot and three wheel lines in 1987. With economic improvement, the cooperator has become much more supportive of wildlife projects in ensuing years.

Farming in the Uintah Basin is still a difficult business, but irrigation improvements have improved crop yields, reduced labor requirements, and enhanced the cooperators ability to weather dry years.

Future monitoring efforts are expected to study broader issues of how salinity control programs have affected community and society in general. Such studies may focus on the effect of fluctuating water availability on production and how well such variables are mitigated by salinity control projects.

One hundred percent of this year's survey respondents believe that salinity control programs have a positive economic affect on the area and region.

Positive economic impact on the area was recently recognized when the Duchesne County Area Chamber of Commerce awarded USDA Natural Resources Conservation Service and Farm Service Agency, an Outstanding Contribution to Agriculture Award for Colorado River Salinity Control Programs.

A cursory look at the 1997 Farm Census indicates that, on average, yields are well above pre-program levels, on a county basis, in spite of three consecutive years of drought. The 2002 Farm Census will be available in June, 2004, and will be addressed in the 2004 report.

Irrigation Water Management contracts provide monetary incentive for the cooperator to learn and apply technical knowledge that results in maximizing profit to the cooperator and salt load reduction for the Colorado River.

Salinity control programs have a stabilizing effect on farmers, their communities, the region, and the environment.

## Appendix 1, 2003 Cooperator's Survey Summary.

| | | | | | |
|---|---|---|---|---|---|
| Random Selection Number | | | | | |
| Operation Name | Duchesne County Totals* | | | | |
| Contract Number or Year | | | | | |
| Irrigated Acres | Flood | Wheel Line | Hand Line | Pivot | Total |
| | 400 | 1186 | 78 | 390 | 2054 |
| Is the contract active and the land being cropped? (Circle One) | Yes | No | | | |
| | 23 | 0 | | | |
| Crop Acres | alfalfa | pasture | grains | other | |
| | 994 | 835 | 465 | 237 | |
| Is the current irrigation system the same as designed and planned at start of contract? (Circle one) | Substantially improved | Slightly improved | Same as designed | Slightly degraded | Substantially degraded |
| | 5 | 2 | 16 | 1 | 0 |

**Describe any changes to and the general condition of sprinkling equipment:**

Added Pump and hose line
Wheel Lines 20+ years old need replaced
Upgraded storage area and capacity
The new movers start easier and Better. The pivots a lot better used less water.
Added 17 wheels and nozzles
Some deterioration due to age.
Our irrigation system is the same as designed but one getting old. 2004 will be the 17th year that we have used
Good condition
No changes-Equipment in excellent condition
No changes and system is in very good shape.
No changes- New Condition
In Good condition- No changes

| | | | | | |
|---|---|---|---|---|---|
| Is water measured? (Circle one) | Yes | No | | | |
| | 16 | 10 | | | |
| If Yes, acre-ft/acre applied? | 30.15 | | | | |
| Is soil moisture monitoring used for irrigation scheduling? (Circle one) | Yes | No | | | |
| | 6 | 19 | | | |
| If yes, what type? (Circle all that apply) | "Feel" method | Tensio- meters | Gypsum blocks | Neutron probe | Remote sensing |
| | 5 | 0 | 0 | 1 | 1 |
| Are Evapotranspiration calculations used for irrigation timing? (Circle | Yes | No | | | |
| | 4 | 21 | | | |
| Have you attended any irrigation water management classes, workshops, or demonstrations? | In the last 12 months? | In the last 2 years? | In the last 5 years? | Never? | |
| | 6 | 4 | 2 | 14 | |
| Do you employ or use a consultant or service that advises irrigation | Yes | No | | | |
| | 4 | 22 | | | |
| Have the changes in yield, labor used, irrigation operation and | Yes | No | | | |
| | 16 | 8 | | | |
| My initial investment for the new system resulted in: (Circle one) | Substantial economic gain | Minor economic gain | No economic change | Minor economic loss | Substantial economic loss |
| | 9 | 12 | 4 | 1 | 0 |
| Do you feel that there is an effect economically overall to your area and region from this program? | Substantial positive effect | Slight positive effect | No effect | Slight negative effect | Substantial negative effect |
| | 20 | 6 | 0 | 0 | 0 |
| Has this project changed the quantity and quality of wildlife on your property? (Circle one) | Substantial positive effect | Slight positive effect | No effect | Slight negative effect | Substantial negative effect |
| | 6 | 10 | 8 | 0 | 1 |

* There were no surveys done in Uintah County

**Appendix 2 – Examples of Wildlife Habitat Replacement Practices.**

| NRCS Practice | NRCS Practice Number | Units Measured |
|---|---|---|
| Field Border | 386 | Linear Foot |
| Hedgerow Planting | 422 | Linear Foot |
| Pond | 378 | Number |
| Restoration and Management of Declining Habitat | 643 | Acres |
| Riparian Forest Buffer | 391 | Acres |
| Riparian Herbaceous Cover | 390 | Acres |
| Streambank and Shoreline Protection | 580 | Linear Foot |
| Stream Channel Stabilization | 584 | Linear Foot |
| Stream Habitat Improvement and Management | 395 | Acres |
| Tree/Shrub Establishment | 612 | Acres |
| Upland Wildlife Habitat Management | 645 | Acres |
| Wetland Creation | 658 | Acres |
| Wetland Enhancement | 659 | Acres |
| Wetland Restoration | 657 | Acres |
| Wetland Wildlife Habitat Management | 644 | Acres |
| Wildlife Watering Facility | 648 | Number |
| Windbreak/Shelterbelt Establishment | 380 | Linear Foot |

**Note: NRCS Field Office Technical Guide, Section IV may be accessed on the Internet at http://www.nrcs.usda.gov/technical/efotg/.**

# Uintah Basin M&E Case Study 2003-1

**1987 Sprinkler Irrigation Project**

## Farm Description:

This 605 acre family farm has been in production for nearly fifty-one years. At various times, it has supported beef cattle, dairy cattle, and other miscellaneous farming activities. The primary crop is alfalfa for livestock feeding, with grain rotations on 245 acres.

## Water Right

The farm owns a 465 acre high water right. Water is available until river flow declines to a predetermined level, making it practical to take all water possible when it is available. In dry years, irrigation can end as early as the beginning of August.

## Pre-Treatment Conditions:

Before the installation of sprinkler systems in 1987, this 605 acre farm consisted of 339 acres of irrigated pasture, 93 acres of irrigated cropland, and 173 acres of range and wildlife habitat, supporting 50 dairy cows and 40 beef cows. The owners had built several small ponds to diversify irrigation needs, water livestock, and enhance wildlife habitat.

## Conservation Plan:

In 1987, a center pivot and five wheel lines were installed, supplied by approximately 8,400 feet of buried pipe, providing gravity pressured water to the system. A separate spring was developed for stock watering beyond the irrigation season. Under the plan, there are 245 acres of sprinkler irrigated cropland, 22 acres of sprinkler irrigated pasture, and 200 acres of flood irrigated pasture.

## Salinity Control:

Monitoring and Evaluation activities in the Uintah Basin have demonstrated that installed sprinklers, when operated per USDA-NRCS approved design, will achieve projected salt savings.

Flow rate checks, using an ultrasonic flow meter in spring of 2003, indicate that installed sprinklers are operating within 10% of design flow rates. Maintenance appears to be generally good, although wheel line end connections are wearing out and many need to be replaced.

Salt Savings, calculated in 1986, were 180 tons/year for three wheel lines and the Center Pivot. Using current methods, calculated salt savings are 252 tons/year for the wheel lines and 334 tons/year for the Center Pivot (Total 586 tons/year), netting an amortized cost on the order of $17/ton/year.

## Economics

With the installation of sprinklers, much of the irrigated land was converted from pastureland to alfalfa/hay production. Landowner's records indicate production increases on the order of 40% where alfalfa fields were converted from flood to sprinkler irrigation, and 60% where fields were upgraded from pasture to alfalfa, small grains, and corn silage. Prior to sprinkler installation, the farm supported 50 dairy cows and 40 beef cows. After installing sprinklers, farmers were able to increase the herd to 100 dairy cows and 80 beef cows.

In recent years, installed sprinklers have enabled farmers to continue operation at reasonably normal levels, in spite of serious water shortages.

## Wildlife

The tenant, who has spent over 40 years on this farm, opines that the numbers of pheasants and sage grouse have decreased over time, and that deer and quail have increased. He has no opinion on whether or not irrigation improvements have been a significant factor in these changes.

With the addition of six ponds, he is certain that wetland acreage has increased significantly from what existed in the 1960's, resulting in increased waterfowl and other wildlife activity in wet areas.

## References


1. "FRAMEWORK PLAN FOR MONITORING AND EVALUATING THE COLORADO RIVER SALINITY CONTROLL PROGRAMS of the U.S. Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS)", May, 2002.

2. "QUALITY OF WATER COLORADO RIVER BASIN – Progress Report #20", U.S. Department of the Interior, 2001.

3. "Colorado River Salinity Control Program, Uintah Basin Unit, Monitoring and Evaluation Reports", 1989 – 2001.

4. 2002 Final Mason Report 1016021. An Excel spreadsheet by David Mason, National Salinity Program Manager, NRCS Headquarters.

5. "Colorado River Salinity Control Program, Uintah Basin Unit, Monitoring and Evaluation, 2001 Report", Draper, Brent W., Goins, Donald J., Lundstrom, D. Nick.

6. Habitat Evaluation Procedures, U.S. Fish and Wildlife Service 1980.

7. "Salt Primer – Water and Salt Budgets", John C. Hedlund, Soil Conservation Service, 1992.